Preface

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The United Nations University asked the Institute of Developing Economies in Tokyo to analyse what made it possible for Japan, once an importer of foreign technology, to become an exporter of its own technology.

What prompted the University to propose this was no doubt its realization that the solution of current development problems in the developing countries is a matter of global importance and that, for the development of each, technology transfer leading to self-reliance is necessary.

In addition, to delve into the history of industrial technology in modern Japan from the perspective of the development problem presented us with an interesting academic challenge. One principal difficulty, however, was also anticipated: the current thrust of comparative technological studies in Japan, in both academic and business circles, is overwhelmingly centred on comparison between Japan and the West, ignoring the third world.

Although not all the difficulties faced in our project, with its emphasis on field studies, were overcome, we were fortunate in securing the ready co-operation of more than 120 experts from all parts of Japan in various fields of industrial technology. The project involved a year of preparatory work and another year of editorial work, and the Institute of Developing Economies covered all expenses for several staff members assigned to the project. The contribution from the United Nations University went to research activities and also to building a network both within and outside of Japan.

More than 120 interim papers and 20 volumes of reports were produced during and after completion of the project. Of the reports, 9 volumes have already been published—in Japanese—by the United Nations University and have been well received. Moreover, besides the present volume, a single-volume English translation-adaptation of two of the Japanese reports has been published by the UNU (*Vocational Education in the Industrialization of Japan*). The remaining reports—10 of which have been translated into English—await publication.

This book is a final report of the whole project on the "Japanese experience." The author served as the project co-ordinator, and though a great part of the information has depended on the project reports, this is not a summary of those reports. Instead, it is an independent work, although its subject and that of the reports supplement each other. Nevertheless, the author's views do not necessarily coincide with those expressed in the reports.

Since the aim of the present book is to provide materials for our "dialogue" with those in the developing countries who are responsible for the planning and administration of national development, in chapter 1 I have added an outline of the history of Japanese industrial technology after World War II, which had not been taken up in our project.

To facilitate more effective dialogue, I also present a theoretical framework: the five Ms constituting technology and the five stages of development, from technology transfer to self-reliance in technology. This framework is useful in explaining the roles played by the four chief industrial branches (iron and steel manufacturing, railways, mining, and textiles, or five if we add the shipbuilding sector, which became a supply source of domestically produced machines that could be used in mining and other branches) in the early years of industrialization in Japan and the links between them and industrial policy.

Our project was unable to cover such important industrial branches as the electrical industry or earthquake-resistant construction. Later research by this author found that the role of the food industry was also important. The OEM (original equipment manufacturer) system, commonly employed in today's electrical and machinery industries, had already been established in the food industry more than 100 years ago. This fact could have bearing on our understanding of biotechnology.

Although Japan was fortunate in having such native technologies, some 60 years were necessary for it to accomplish the first stage of industrial revolution, through technology transfer, and to form a national technology network. In the 1920s, the aforesaid four chief industrial branches and the hydraulic power industry were able to establish links among themselves on a minimal scale and at the lowest level, ensuring a "point of no return." The last to enter that process was the chemical industry, which benefited from the delaying of imports during World War I, followed by rapid growth of the machinery industry in the 1930s after the Great Depression.

Besides the external conditions favouring it, the Japanese economy was able to rehabilitate itself so rapidly in the face of the devastation caused by World War II because four of the five Ms were already in place at notably high standards.

Only after the 1970s did the links among the Ms grow deep enough and wide enough for Japan to become a genuine technology-exporting country, but even before that, Japan had won the world's top position in some technology sectors. It took Japan 120 years to attain high technological development, but that was only half what the West had required. And it is likely that Japan's Asian neighbours will require even less time, say half what it took

Japan, to catch up. An industrial revolution through technology transfer is possible, even if beset with sizable difficulties.

It has often been misunderstood that the latest technologies would prove the ones most appropriate for national development. In Japan's case, it did not always adopt only the latest technologies. When it did, it did so because that technology was considered to be the most appropriate.

It should be noted that the choice to transfer the latest technology is possible only after a country has attained primary self-reliance in technology, at which time it should then purchase only the necessary technological systems, ones without high social costs and conflict.

Self-reliance in technology does not mean autarky. Today's technologically advanced countries are not autarkic in technology. Self-reliance in technology refers to the ability to absorb all needed technologies, and the attainment of this self-reliance is accomplished not at a stroke but in stages.

The more advanced a technology is, the wider its links will be and the higher the level at which it will establish itself as a working engineering system. In other words, advanced technology requires high-level, intricate links between itself and technological pre-conditions and between itself and related services. This requirement explains the reason the technology gap between the North and South tends to widen. The question of utmost importance to a developing country is, therefore, how to form its national system of technology at a minimally effective scale and level.

Since its first stage in acquiring technological self-reliance Japan has been dependent on foreign countries for most of its raw materials, and this characterizes its development in technology. Technological development follows a spiralling rather than a straight path, and the question as to which sector of technology a country with a specific resource position may decide to start with is a matter of national consensus.

There is the "textile first" theory of industrialization, but, while it may describe the approach taken by the industrialized countries, it is not necessarily the path of development other countries should follow. A country may well begin its industrialization with power development, food processing, or communications and transportation. The conditions under which industrialization begins cannot be the same for every country; the only common element required is that a national consensus be formed.

One reason Japan could successfully absorb foreign technology in the nineteenth century was because most of the technology and machinery in those days consisted of an assemblage of assorted technologies. Some machines could be dismantled into separate components, and these components could be replaced by parts produced locally through the traditional skills of carpenters, blacksmiths, stone-cutters, metalworkers, etc. Although replacements were often less efficient and poorer in quality, they satisfied national needs in being less expensive and easier to maintain. The repetition of this process made it possible to eventually turn old technologies into new ones.

As with language, imitation is an important step in learning. This step can

be very much enhanced by making a thorough examination of traditional skills and technologies. Regrettably, this is not being done in many of the developing countries, where even basic data on meteorological, geological, and hydrological conditions and on natural resources are incompletely available. This is an area where international co-operation would be both useful and necessary, but even then, full use of the empirical knowledge of the local populace should be made.

Toward the end of the nineteenth century, Japan climaxed a decade of trial and error in the spinning industry by catching up with India, then an advanced country in this technology. This was possible because in Japan the basic spinning process was subdivided. After workers had acquired the skills of one process, they were transferred to another. This was an unusual but effective on-the-job method of developing worker skills. Although it proved successful in Japan, it may not elsewhere, especially in countries where the system of technology management is largely based on functionalism and where job-hopping among workers and engineers is common. Further, in Japanese industry generally, this style of training has been combined with the distinctive qualities of the Japanese engineer and with such practices as lifetime employment, rare in other societies.

The point is that every country must find its own way of development. However successful the Japanese experience may appear to be in the eyes of other nations, it was an experience unique to Japan and not one for other nations to follow to the letter. All the Japanese can do is attempt to answer questions about its success and contribute something to the information developing countries need as they search for their own development.

Our project differs in approach from conventional studies, and we have given consideration to such areas as vocational education, general trading companies, cottage industries, and problems of pollution. We hope the information provided here will lead the reader to the more detailed information contained in our individual reports.

Our project on the Japanese experience was first proposed by Professor Mushakoji Kinhide, vice-rector at the United Nations University, and the University's Dr. Uchida Takeo contributed much help as the project moved along. In bringing out this English edition, particular mention must be made of the good offices of Mr. Noguchi Noboru in getting the Grant-in-Aid for Publication of Scientific Results from the Ministry of Education, Science and Culture. The author's deep gratitude is due to these persons and to all those concerned with our project. It is his great pleasure that this work is being brought to the attention of English-language readers.

Also, for much of the work on which the book is based, as with the other books in this series, the author owes a great deal of thanks to his colleague, Professor Tada Hirokazu, and to others at the Institute of Developing Economies who worked under his co-ordination in bringing the project to fruition. The translation into English was done by Mr. Yamauchi Takeo and Mr. Nakai Masao, the author's former colleagues at the Institute. Indi-

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